CHAPTER 5

"An incorrectly identified mark is a hazard, not an aid, to navigation."

Alton B. Moody

Aids to Navigation

Introduction and Overview

According to accepted NOAA *Nautical Chart Manual* nomenclature, an *Aid to Navigation* (ATON)...

> "...is a man-made structure/device external to a craft designed to assist in determining the craft's position or a safe course or to warn of dangers or obstructions. When the information is transmitted by light waves, the device is a visual aid to navigation; if by sound waves, an audible aid to navigation; if by radio waves, a radio aid to navigation. Any aid to navigation using electronic equipment, whether or not radio waves are involved, may be considered an electronic aid to navigation. The term "aid to navigation" should not be confused with the more general term "navigational aid" which covers any instrument, device, chart, method, etc., intended to assist in the navigation of a craft."

A more complete list of ATONs and associated information normally found on nautical charts is provided later in this chapter. Briefly, however, ATONs include such objects as buoys, lights, fog signals, daybeacons, range markers, radiobeacons and LORAN-C and Omega lattices. Although the GPS certainly satisfies the definition of an ATON, this system is not discussed in this chapter, because GPS information is not provided on nautical charts. Omega is also not discussed in this manual even though Omega information is provided on certain nautical charts because small craft are not generally equipped with these receivers. Finally, charted LORAN-C information is not included in this manual because this is covered at length in the *USCG LORAN-C User Handbook,* to which the reader is referred.

ATONs may be fixed (land-based or fixed structures in the water) or floating (e.g., buoys). Landmarks are the functional equivalent of ATONs but, because these have not been especially constructed for this purpose, are not formally classified as ATONs. Landmarks are treated in a separate chapter (Chapter 6. Landmarks) of this manual.

This chapter provides information on the type and utility of ATONs and how these are depicted on nautical charts. (Because ATONs are so important to safe navigation and, therefore, charted in great detail, this chapter is long and detailed.) The chapter also identifies the sources of additional information (e.g., the Chart No. 1, *U.S. Coast Pilot* and the *Light List*) which supplement that provided on the nautical chart. As appropriate, practical comments are made throughout the chapter on the correct use of ATONs for marine navigation. (See also

Chapter 6 for additional perspectives applicable to ATONs as well as landmarks.) Numerous references are given at the end of this chapter for those interested in additional detail. Names enclosed in parentheses (e.g., Bowditch) denote particularly pertinent references. The Glossary in appendix A provides definitions of key terms related to ATONs.

Brief Historical Asides

As might be expected, what are now called ATONs have a long history (see, e.g., Bowditch, Naish). As the later history of ATONs may be familiar to readers of this manual, it is interesting to provide some brief asides on the early periods. Towers (used originally as landmarks, and later as lighthouses) were reportedly constructed to aid passage along the Mediterranean coast as early as 660 B.C. Between 283 and 277 B.C., Sostratus of Cnidus built a large (500 ft) structure on the island of Pharos which marked the harbor of Alexandria from the north. The Romans established a network of fire towers along the Mediterranean.

By medieval times, beacons and range markers were in use to facilitate entrance to the ports of Genoa and Pisa. In the so-called Dark Ages in Europe, hermits and monks located on remote islands and promontories displayed light signals in chapels and participated in salvage operations for wrecked vessels. (Today this might be viewed as a conflict of interest!)

The organization of the Hanseatic League not only provided for economic cooperation but also advanced the use of ATONs (and mechanisms for collecting what would now be termed "user fees") for navigation. A surviving chart of the approaches to Bruge dating from about 1500 A.D. shows *buoys* as well as towers. (A seaman's manual of 1295 A.D. refers to buoys marking the river channels to Seville.) In England, Trinity House was established in the early 1500s as a pilotage authority charged with (among other things) the responsibility of constructing and maintaining marks on the land.

By the 1700s ATONs had become relatively sophisticated and widespread. The first recorded range marks in America were two light towers placed in line on Plumb Island to mark the channel to Newburyport, MA, on the Merrimack River.

Importance of ATONs in Coastal Navigation

As with landmarks, ATONs are charted objects used for determining *LOP* (e.g., with a hand-bearing compass or radar or by direct plotting in the case of range markers) and *curves of position* (e.g., circles of position with an optical range finder for ATONs with charted height information, such as certain lights or hyperbolas of position with LORAN-C) so as to determine a fix or estimated position for the vessel. ATONs also mark hazards to navigation, identify the limits to safe channels, designate special-use areas (quarantine and anchorages), and provide other relevant information. Table 5–1 provides both general and specific illustrations of how information derived from ATONs can be used for marine navigation. ATONs can be used to fix the vessel's position, to serve as homing or tracking aids, to ensure that the vessel remains clear of dangerous waters (e.g., by using danger bearings, danger circles, or passing on the "safe side" of buoys) to identify turn points, and for a variety of specialized purposes such as compass calibration or (less frequently with ATONs) to determine whether or not the vessel's anchor is dragging.

Importance of Positive Identification and Related Matters

Before discussing the various types of ATONs, charting practices, and related matters, it is appropriate to emphasize several key points noted throughout this manual.

> The mariner should be *fully familiar with the charting conventions* employed to depict ATONs. And important textual material (e.g., Chart No. 1, and the appropriate *USCG Light List*) should be readily available for reference.
>
> Any observed ATON (or landmark) should be *positively identified* by the mariner prior to its use for navigation. Published texts (e.g., Cahill,

Table 5-1
Utility of ATONs Shown on Nautical Chart

GENERAL:

- Used for determining range or bearing by visual means (or radar) in coastal waters so as to determine a fix or estimated position;

SPECIFIC ILLUSTRATIONS:

- Used for determination of fix, running fix, estimated position, set and drift of current;
- Used for plotting danger bearings, danger circles, horizontal danger angles;
- Used (in conjunction with danger bearing or circle) for evaluation of vessel's position with respect to unobservable hazards to navigation;
- Used to determine a safe course which avoids unobservable hazards to navigation;
- Used for establishing vessel turning bearings;
- Used for homing or tracking purposes;
- Used for compass calibration; and
- (Less frequently) Used for determining whether or not an anchor is dragging.

Milligan, Maxim) and USCG accident files are replete with examples of mishaps or accidents which resulted from the incorrect identification of an ATON. Bowditch (see references) lists "failure to identify aids to navigation" as the second of 16 common errors in navigation. The mere observation of an ATON (or landmark) at approximately the right position and at approximately the right time—although relevant—is not sufficient proof that the aid observed is the same as that shown on the chart. ATONs are equipped with numerous characteristics (e.g., the flash characteristics and color of a light, the Morse code identifier of a radiobeacon, the number and color of an unlighted buoy or daybeacon) to facilitate positive identification.

Closely related to the above point, it is important that charts (and such publications as the *Light List* and *U.S. Coast Pilot*) be amended as described in the *latest published corrections.* ATONs are moved, renumbered, removed, and/or characteristics changed periodically. This can have significant consequences (see Cahill) for the uninformed mariner. Bowditch also lists "failure to correct charts" among the common errors in navigation.

Whenever observations are taken on any fixed ATON or landmark, this *information should be plotted* on the nautical chart by the mariner. Even a single LOP can be useful, and frequent fixes are typically necessary in coastal waters where ATONs are placed. Differences between the vessel's dead reckoning position and the plotted fix enable currents to be estimated and/or should alert the mariner to the possibility of other errors.

Finally, *all available means* (e.g., maintenance of a dead reckoning plot, use of GPS, LORAN-C, depth sounder or other means) *should be*

used for navigation. Reliance on only one method is unprofessional and unwise.

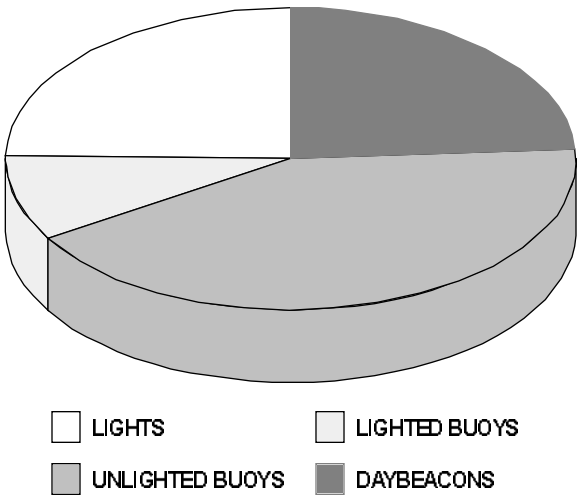
ATONs and Related Chart Information (General)

This chapter includes the following ATONs: lights, buoys, fog signals, daybeacons, ranges, and radiobeacons. These are discussed in order in the following sections. Brief comments on "trial courses" are also included in this chapter. The symbols used in charting these aids are illustrated in Sections P, Q, R, and S of *Chart No. 1, Nautical Chart Symbols, Abbreviations, and Terms* (Ninth Ed.) to which the reader is referred. (Pertinent excerpts from Chart No. 1 are included in this chapter for ready reference.)

ATONs are placed in appropriate locations in harbors and inland waterways to facilitate navigation. The placement of these ATONs follow a particular pattern or convention termed *the lateral system,* in which the colors, shapes, and numbering of lights, buoys, and daybeacons are determined by their position in relation to "safe water." (In virtually all U.S. waters the *International Association of Lighthouse Authorities* (IALA) System B is followed. Therefore, the IALA-B system is discussed in this manual.) These designations are applied to navigable channels proceeding from seaward toward the head (limit) of navigation. The colors and numbers of buoys and lights along the coasts and along traffic routes not leading distinctly from seaward or toward headwaters follow the same system, but applied so that even-numbered aids mark the starboard side when proceeding in southerly direction along the Atlantic coast, in a northerly and westerly direction along the gulf coast, and in a northerly direction along the Pacific coast. Table 5–2 provides a capsule summary of the characteristics of lateral aid in most U.S. waters. Additional information on buoyage systems can be found in the *Light List* and other references (e.g., *Coast Guard Aids to Navigation,* Chapman).

Most ATONs used by mariners on a day-to-day basis for navigation purposes are maintained by the USCG. In 1993, there were approximately 50,500 federal ATONs in U.S. waters (Ihnat)! These aids include lights, buoys (lighted and unlighted), daybeacons, and approximately 200 marine radiobeacons. As shown in figure 5–1, the majority (51 percent) of these ATONs are buoys—lights (25 percent) and daybeacons (24 percent) account for about equal portions of the remainder. (Fog signals are not included in this tabulation, as these are typically collocated with a buoy or light.) In addition to federally maintained ATONs, there are approximately the same number of privately maintained ATONs. Some privately maintained aids are useful for navigation and are tabulated in the *Light List* and shown on nautical charts. Charting federal aids (let alone some fraction of the private aids) and keeping charts up to date, is obviously a large undertaking.

An ATON is charted if it is in the *Light List* or is assigned a *Light List* number when published in the LNM. Thus, any ATON found



SOURCE: USCG

Fig. 5-1. Distribution of the more than 50,500 Federal ATONs in U.S. waters in 1993; buoys are most numerous.

Table 5-2
Characteristics of IALA-B Lateral System

Characteristic	Port Hand Marks	Starboard Hand Marks
Color	Green	Red
Shape (buoys)	Cylindrical (can) or pillar	Conical (nun) or pillar
Daymark	Green square	Red triangle
Light color (when fitted)	Green	Red
Reflector color	Green	Red
Numbers (if numbered)	Odd	Even

At a point where a channel divides, when proceeding in the "conventional direction of buoyage," a preferred channel in Region B may be indicated by a modified port or starboard lateral mark as follows:

Characteristic	Preferred Channel to Starboard	Preferred Channel to Port
Color	Green with one broad red horizontal band	Red with one broad green horizontal band
Shape (buoys)	Cylindrical (can) or pillar	Conical (nun) or pillar
Daymark	Green square, lower half red	Red triangle, lower half green
Color	Green	Red
Rhythm	Composite group flashing (2+1)	Composite group flashing (2+1)
Reflector color	Green	Red

CAUTION: When proceeding toward sea, it may not always be possible to pass on either side of preferred channel aids to navigation. The appropriate nautical chart should always be consulted.

in the *Light List* will also be found on the chart.[1] Additionally, some ATONs are charted which are not in the *Light List,* such as those established by neighboring foreign countries, aids having "reliable" maintenance authorities (such as those established by the military), and environmental buoys which are not included in the *Light List.* As well, radar reflectors, lights, and sound signals are charted for those features (e.g., floats, targets, platforms, dredging range markers, and data collection buoys) not specifically intended for use in navigation, whether the feature is listed in the *Light List* or not.

[1]This assumes that the chart has been *corrected* based upon data in the LNM.

ATON information provided on nautical charts includes a *symbol* unique to each class of aid and a set of *characteristics* such as number, height, color, and nominal range. These characteristics are provided in *labels.* Symbols and characteristics are placed so as to be readily identified by the chart user (not obscured by less important information) and to avoid overlap with any charted channels. These standard symbols are reserved for ATONs which appear in the *Light List.* Charted lights and beacons not intended as guides for normal surface navigation are shown with a *landmark symbol* (see Nautical Chart Manual, Chapter 6. Landmarks) and identifying label. Any identifying navigational light or beacon that is not established by the USCG or equivalent authority is identified on the charts either by the label "Priv" (for privately maintained aids) or by naming the agency that is responsible for its maintenance.

Temporary aids are seldom charted unless given a *Light List* number. ATONs established (and/or aid characteristics that are changed) for the winter navigation season are considered temporary aids and these (changes) are not charted. However, specific details for important aids, such as seasonal fog signals at major aids, are charted in all areas. A seasonal aid note is found on all Great Lakes charts and on east coast charts from Cape Henry, VA, northward. This note reads as follows:

SEASONAL AIDS

"During some winter months or when endangered by ice, certain aids to navigation are replaced by other types or removed. For details see the U.S. Coast Guard *Light List.*"

Lights

According to official charting definitions in the *Desk Reference Guide,* a *light...*

> "is a luminous signal emitted by a *fixed structure*[2] to aid navigation that marks channels, warns of dangers or obstructions to navigation, and assists the mariner in determining his position. Lights are identified by their characteristics at night and by the shape and color of their daymarks. Light characteristics include flash sequence, length of light and dark periods, color, and range of visibility. Lights are categorized by function (e.g., junction light, directional light, range light, leading light, sector light, passing light, and aeronautical light)." [Emphasis added.]

There were approximately 12,200 federally maintained lights in U.S. waters in 1993.

Most lighted ATONs (including lights and lighted buoys) are equipped with controls that automatically cause the light to operate during darkness and to be extinguished during daylight. These devices are not of equal sensitivity and, in consequence, all lights do not come on or go off at the same time. The lighting apparatus is serviced at periodic intervals, but there is always the possibility that the light is extinguished or operating improperly.

Lights can be used for navigation during the hours of daylight or darkness. During daylight, the fixed structures associated with these lights serve as *landmarks* for bearing or range determination. During daylight hours, the identification of the light is based upon the position of the light and its physical appearance. (The physical appearance of a

[2]Lighted buoys are classified by NOAA as *buoys,* rather than lights, and are discussed later in the main text.

light structure is *not* found on the chart, however, as noted below.) At night, the light is used in much the same manner except that the identification of the light is based primarily upon the *characteristics* of the light, such as the *color, flash sequence,* and *position.*

–Charting Practices

This section provides information on charting practices for lights and related information. Charting conventions consist of a light *symbol,* associated *labels and notes,* and (for sectored lights or where lights have obscured sectors) *information on the sector(s).*

–Symbol (P)

Major lights, minor lights, and lighthouses are charted as shown in Section P of Chart No. 1. In particular, the position of the light is shown by a black 0.75 mm dot (or open black circle 1.0 mm in diameter in the case of an articulated light), with a magenta "flare" (3.4 mm in length with a rounded end of 0.6 mm radius) drawn about 1 mm from the light dot. This light *symbol* has the visual appearance of an exclamation mark (!) in print. The flare is generally oriented toward the label and is drawn to avoid obscuring other relevant chart detail. Where possible, the flare orientation is aligned with those of neighboring buoy symbols (see below). Leading lights (i.e., those arranged, similar to range lights—except that only a single light is used—to indicate a path to be followed) may be charted with the flare oriented seaward along the line.

–Labels and Notes

The label and note(s) provide information on the *name* of the light and the light's *characteristics,* including the light number (if any). This information is very useful for identifying the light and for determining whether it can be seen from the vessel's approximate position.

Miah Maull shoal light in Delaware Bay
Official U.S. Coast Guard photograph

If the name of the light appears in the *Light List* and space permits, the name of the light is shown in black conventional (vertical) type above the light characteristics.[3] The name may be omitted if it is the same as the name of the geographic feature in the immediate vicinity and space is at a premium. Thus, for example, if the geographic name "Pt Judith" were shown in the chart, the name "Pt Judith Lt" would not be given.

The characteristics of the light include its *flash characteristic, color, period, height, visibility (nominal range),* and *number.*

Flash characteristics include the sequence and timing of the flashes and include fixed, occulting (single occulting, group occulting, and composite group occulting) isophase,

[3]These are shown in conventional, rather than italic type because italic type refers, among other things, to floating structures. See also Chapter 4.

flashing (including single flashing, group flashing, composite group flashing, quick, very quick, and ultra quick), Morse code (e.g., Morse "A"), fixed and flashing, and alternating. Illustrative flash characteristics and associated chart labels are shown in Section P (10.1 to 10.11) of Chart No. 1, which is reproduced in figure 5–2. Although not particularly complex, this diagram requires some study. Study of this illustration should be supplemented with on-the-water practice in identifying the characteristics of lights. Mariners are also cautioned that if a vessel has considerable vertical motion due to pitching in heavy seas, a light sighted on or near the horizon may alternately appear and disappear with the possible result that its true characteristic will not be apparent. In consequence, the light could be misidentified. Under these conditions, the true characteristic may not be apparent until the vessel is closer to the light. The watch stander should be placed at the highest convenient station for such observation.

The *color* of lights is shown using standard abbreviation (e.g., R for red, G for green, W for white, etc., as shown in Sections P 11.2 through 11.8 of Chart No. 1) following the flash characteristics of the light. Generally, white lights are not so labeled (and if no color is shown, on the chart, white can be assumed) except where a light exhibits more than one color, in which case W is shown. Amber lights are charted as yellow and abbreviated "Y." Although the color of a light is important to its identification, mariners should be aware that the apparent color of the light may change with distance, because the various colored lights may have different nominal ranges (see below). Additionally, ice or snow may cover the panes of unattended lights, greatly reducing the visibility of lights (see below) and may cause colored lights to appear white.

The *period* of a light is defined as the time (in seconds) required to exhibit a full pattern together with the interval between patterns. Periods are shown on the nautical chart, to the nearest tenth of a second expressed as a decimal, after the flash characteristic. Mariners should "time" a light using a stopwatch. To increase the precision of measurement for lights with short periods, the aggregate time required to complete several cycles should be measured. Thus, for example, if 60 seconds were required for 10 cycles, the period would be 6 seconds.

Taken together, the flash characteristic, color, and period provide key information necessary to *identify* the light when it is in operation. According to both the *Admiralty Manual of Navigation* and Bowditch, *the characteristics of a light must always be checked on sighting.* As noted by Moody, "An incorrectly identified mark is a *hazard,* not an aid, to navigation."

The *height* of the light is the vertical distance between the light source (not the top of the light!) and the shoreline reference datum. Height is shown in feet using the abbreviation "ft" except on metric charts, where height is shown in meters using the abbreviation "m." Height information is important for distance-off calculations (see Bowditch) in daytime or for estimating the distance at which a light can be seen at night (see below). Normally, the mariner should search for the highest lights first when approaching a coast—as these are likely to be seen most easily. However, the mariner should bear in mind that lights placed at high elevations are more frequently obscured by clouds, mist, or fog than those lights located at or near sea level.

The *visibility* of the light is expressed as the "nominal range," and is charted except in the case of range lights or privately maintained lights.[4] The *nominal range* is the maximum distance (in nautical miles on most charts, in statute miles on most Great Lakes charts) a light may be seen *at night* in clear

[4]The nominal range is not given in the *USCG Light List* either, because these are very short-range ATONs.

Light Characters

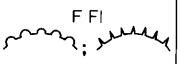
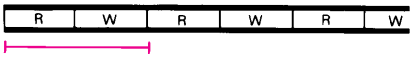
Light Characters on Light Buoys → Q

	Abbreviation		Class of light	Illustration — Period shown	
	International	National			
10.1	**F**	F	*Fixed*		F
10.2	*Occulting (total duration of light longer than total duration of darkness)*				
	Oc	Oc; Occ	*Single-occulting*		Oc; Occ
	Oc(2) Example	Oc (2); Gp Occ	*Group-occulting*		Oc (2); Gp Occ
	Oc(2+3) Example	Oc(2+3)	*Composite group-occulting*		Oc(2+3)
10.3	*Isophase (duration of light and darkness equal)*				
	Iso	Iso; E Int	*Isophase*		Iso; E Int
10.4	*Flashing (total duration of light shorter than total duration of darkness)*				
	Fl	Fl	*Single-flashing*		Fl
	Fl(3) Example	Fl (2); Gp Fl	*Group-flashing*		Fl (2); Gp Fl
	Fl(2+1) Example	Fl (2+1)	*Composite group-flashing*		Fl (2+1)
10.5	**LFl**	L Fl	*Long-flashing (flash 2 s or longer)*		L Fl
10.6	*Quick (repetition rate of 50 to 79 – usually either 50 or 60 – flashes per minute)*				
	Q	Q; Qk Fl	*Continuous quick*		Q; Qk Fl
	Q(3) Example	Q(3)	*Group quick*		
	IQ	IQ; Int Qk Fl; I Qk Fl	*Interrupted quick*		IQ; Int Qk Fl; I Qk Fl

Source: Chart No. 1.

Fig. 5-2. Illustrative Flash Characteristics

Continued on next page

	Abbreviation		Class of light	Illustration — Period shown	
	International	National			
	Very quick (repetition rate of 80 to 159 – usually either 100 or 120 – flashes per min)				
10.7	VQ	VQ; V Qk Fl	*Continuous very quick*		VQ; V Qk Fl 
	VQ(3) Example	VQ (3)	*Group very quick*		
	IVQ	IVQ	*Interrupted very quick*		
	Ultra quick (repetition rate of 160 or more – usually 240 to 300 – flashes per min)				
10.8	UQ	UQ	*Continuous ultra quick*		
	IUQ	IUQ	*Interrupted ultra quick*		
10.9	Mo (A) Example	Mo (A)	*Morse Code*		
10.10	FFl	F Fl	*Fixed and flashing*		F Fl 
10.11	Al.WR	Al; Alt	*Alternating*		Al; Alt 

Source: Chart No. 1.

Continued

Fig. 5-2. Illustrative Flash Characteristics

weather (meteorological visibility of 10 nautical miles) without regard for the height of the light or the observer. For those lights with two or more colors (see below) either both nominal ranges are shown (e.g., 15/10M) or *the lesser of the two* ranges will be given.

Calculation procedures for estimating the *actual distance from which a light can be seen at night,* considering the height of the light and observer, nominal range, and prevailing visibility, are detailed in the *Light List* and other references (e.g., Bowditch, Dutton, Maxim). Common practice for the navigator is to draw circles around these lights on the chart with radius equal to the distance at which the light is likely to be visible (see Schlereth) and to estimate the corresponding time when these should first be seen. These calculations are only approximate (Burch). Nonetheless, if lights are not sighted within a reasonable time after that predicted, a dangerous situation may exist and the mariner should be appropriately cautious.

Finally, the assigned *number or letter(s)* of the light structure (if any) are shown following the visibility, and enclosed in quotation marks. The number or letter can be observed (e.g., with binoculars) during daylight hours.

On large-scale charts, the characteristics of lights are shown in the following order: flash characteristic, color, period, height, visibility, and number. For example, an 85 foot red light (number "2") of nominal range 10 miles which exhibits a group of three flashes within a period of 10 seconds would include

the light symbol, light name (if appropriate) and the label: Fl (3) R 10s 85ft 10M "2."

Small-scale charts show complete information regarding characteristics for major seacoast lights expected to be used for coastal navigation, but may omit certain information in cases where congestion is a problem. In this event, characteristics are omitted in the following order: height, period, number of flashes in groups, the number or letter on the structure, and the nominal visibility.

–Sectors, and Related Matters

In some cases, terrain masking (e.g., a mountain or island) may limit the area over which a light may be seen. Knowledge of these "blind" areas is obviously useful to mariners. (There is, after all, no point in looking for something that cannot be seen. Moreover, a prudent mariner might well alter the intended track so as to avoid an obscured sector of a major light.) An *obscured* sector (sometimes termed "dark sector") is a portion of the light sector of a navigational light in which the light is not visible. Where a LNM reports its establishment, the obscured sector (see Section P 43 of Chart No. 1) is charted with dashed "rays" marking the limits of the obscured sector. Additionally a dashed arc in the sector centered on the light indicates the obscured sector. Directional arrows are used to mark the points where the dashed arc intersects the dashed ray line. A label, "LT OBSC" or "DARK SECTOR," is added for clarity. See figure 5–3 for an illustration of a light with an observed sector taken from NOS Chart No. 13218.

In other cases, sectors are deliberately created by placing colored glass in the lanterns of lights to provide additional information to the mariner. Sector lights (see Sections P 40 and 42 of Chart No. 1 for symbology) are used primarily to warn mariners of dangerous shoals or other hazards to surface navigation. The danger sectors are usually red and are charted (in degrees true) from the perspective of the mariner looking *toward* the light. Mariners are cautioned not to alter course based solely on the observed sectors, but rather to note the correct compass bearing. This is because it is difficult to determine the sector boundaries with accuracy because the edges of a colored sector cannot be sharply demarcated.

Figure 5–4 presents an excerpt from NOS Chart No. 12304 which shows a red sector on the Brandywine Shoals Light warning of shoals in this area.

–Directional Lights

Several types of *directional lights* are in use (see Section P 30 of Chart No. 1 for chart conventions). These lights have a very narrow sector designed to mark a direction to be followed. The narrow sector may be flanked by an obscured or intensified light, or by lights of a different color or characteristic. A direc-

Fourteen Ft. Bank Light in Delaware Bay. Note differences in appearance with Miah Maull shown earlier.
Official U.S. Coast Guard Photograph.

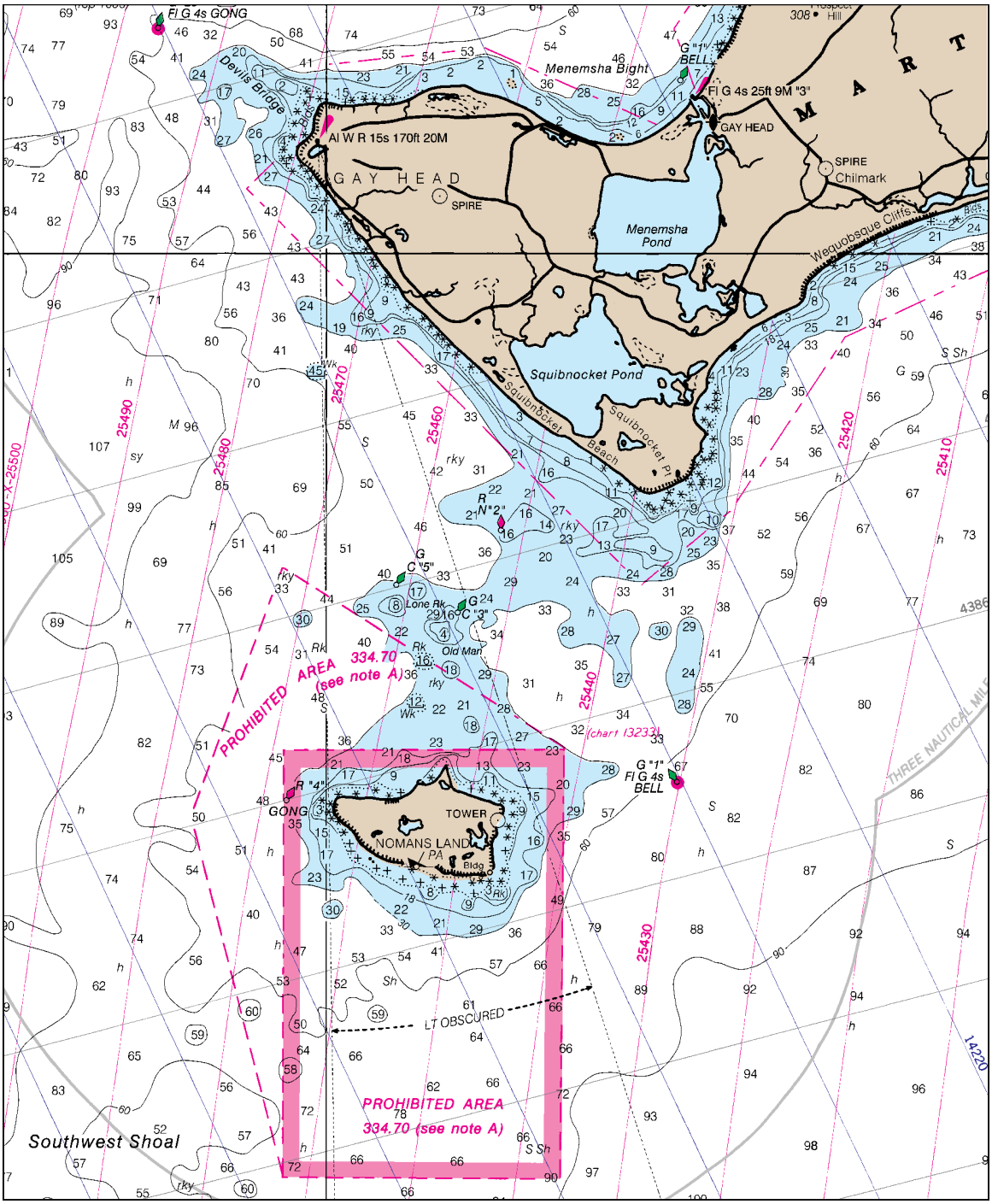


Fig. 5-3. Excerpt from NOS Chart No. 13218 (Martha's Vineyard to Block Island). Note the obscured sector of the Gay Head Light south of Nomans Land. The light at Gay Head is an alternating red and white with a period of 15 seconds and a nominal range of 20 nautical miles. The height of this light is 170 ft.

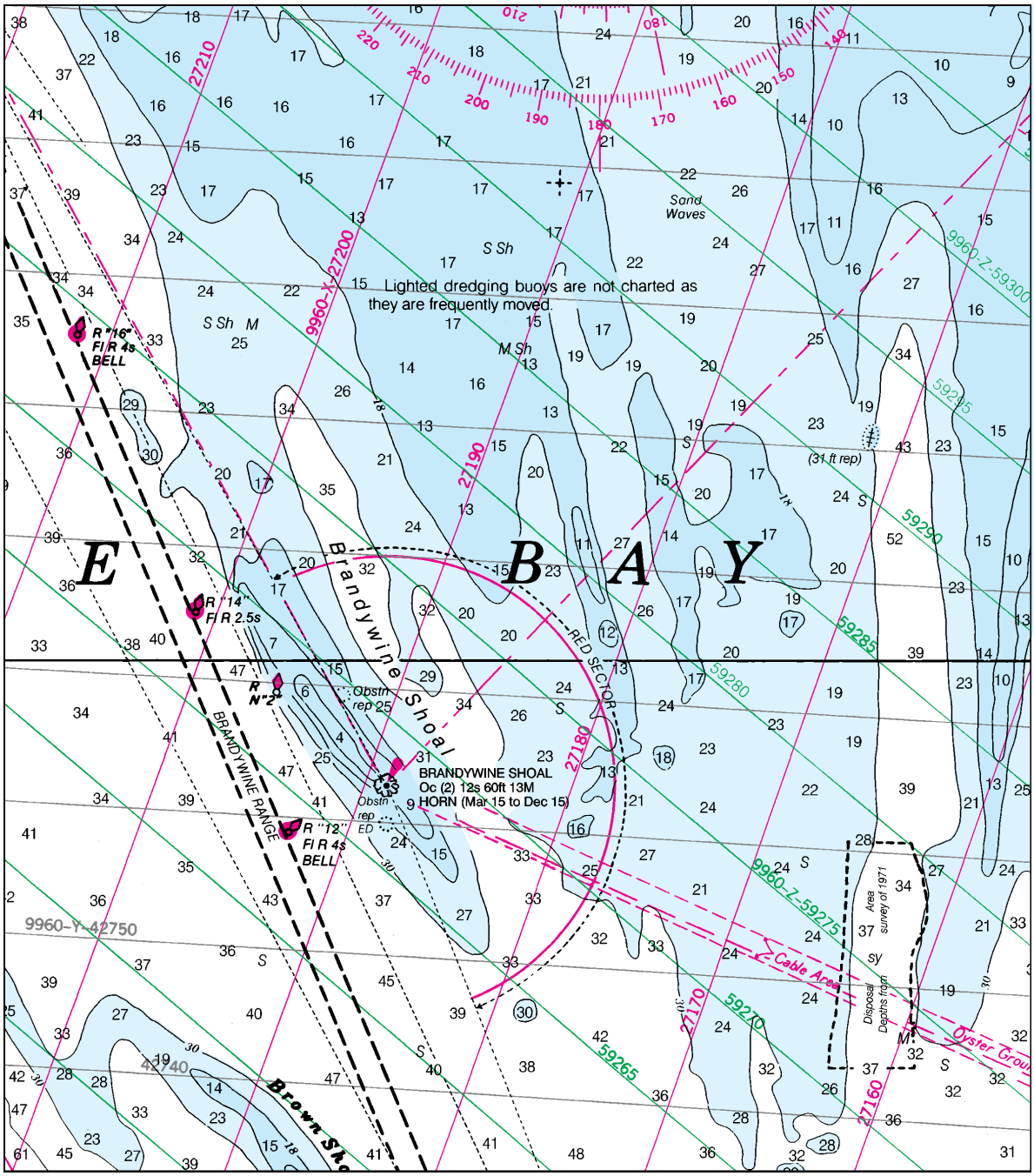


Fig. 5-4. Excerpt from NOS Chart No. 12304 (Delaware Bay). Note the red sector of the Brandywine Shoal Light. The 60 ft. light has a nominal range of 13 nautical miles. Reference to the *Light List* indicates that this is the lesser of the 17-mile range of the white light and the 13-mile range of the red sector. The horn, according to the *Light List*, emits a 2-second blast every 15 seconds. The light is a group occulting with a 12-second period. Note also the riprap symbol at the base of the light.

tional light normally shows three adjoining sectors of red, white, and green, with the center white beam oriented to mark the channel.

–Leading Light

A *leading light* (see Section P 20 of Chart No. 1 for chart conventions) is similar to a range light or marker (see below) except that it marks a channel with a single light (with ray lines) rather than with two separate lights. It is usually a high intensity beam marking the safe channel which diminishes to much lower intensities around the remainder of the horizon. It differs from a directional light (see above) in that it shows only one color of light instead of the three-color sectors of the directional light.

–Aeronautical Lights

Aeronautical lights (see Section P 60 of Chart No. 1 for chart conventions) are white and green navigation lights associated with airports and often found atop the control tower. Because these are generally attended during their hours of operation, the lights are highly dependable. Moreover, these are often the most conspicuous of the nonstrobe lights and their nominal range may be greater than those established for marine navigation. The aeronautical light is charted by a standard light dot with magenta flare. The light symbol is accompanied by its characteristics and the label "AERO."

–Articulated Lights

An *articulated light* is a floating light, also called a *buoyant beacon.* It is basically a vertical pipe structure that oscillates around a universal coupling connected to a sinker. The light structure (which is typically 10 feet to 15 feet above the water surface at high tide) is kept upright by the buoyancy of a submerged floatation chamber. Unlike other buoys (see below) it has no "scope" of chain and the light is directly over the sinker, i.e., this structure has no "watch circle." It is designed primarily to mark narrow channels with greater precision than conventional buoys in situations where the depth of water, up to 60 feet, is too great for a normal pile or dolphin light structure (see Dutton).

When first introduced, this type of ATON, which is neither a true buoy nor exactly a fixed light, required a new symbol for charting (see Section P 5 of Chart No. 1). This symbol is a black open circle 1.0 mm in diameter (the "approximate position" symbol for a landmark explained in Chapter 6) centered on the published position with a magenta flare. The open circle is chosen in lieu of a dot (used for other fixed lights) because the structure may be displaced more than 10 feet of its "true" position. The articulated light is labeled *"Art"* in Newton Medium italic type.[5]

–Strobe Lights

Many charted features are marked with very quick-flashing high-intensity lights, called strobe lights. The light is usually a xenon gas condenser-discharge flash lamp or flash tube. Strobe lights are used on certain USCG-maintained ATONs and on aeronautical hazards, such as stacks, towers, and buildings. ATONs published in the NM and *Light List* as well as landmarks with a strobe light include the label "Strobe" as well as other label elements (see above). The flash period of a strobe light is usually (but not always) omitted because of its extremely short duration (much less than 1 second).

[5]The reason italics are used (in lieu of the vertical lettering found on other lights) is that articulated lights—though classified as fixed structures—are floating lights. Buoys are also labeled in italic type.

–Riprap

Riprap are mounds of broken rock, cobbles, boulders, or fragments that are often placed around light structures as protection against ice damage and scouring by fast-moving currents. Desirable as the use of riprap may be from the point of view of protecting the structure—and helping to ensure the reliability of the light—riprap also presents a *hazard to navigation* for vessels that pass too close aboard. Riprap is denoted on nautical charts by a special symbol (see Section P a of Chart No. 1).

Supplemental Information Regarding Lights and Other ATONs

In addition to the nautical chart, the *Light List,* the *U.S. Coast Pilot,* and commercial cruising guides offer relevant information on ATONs. Additional information provided in these sources is briefly discussed below.

–The *Light List*

The *Light List* is the authoritative source of information on ATONs. It is published annually by the USCG in several volumes, covering various geographic areas. The *Light List* is a valuable complement to the nautical chart and provides specific information on ATONs. Contrary to the implication of its title, the *Light List* offers information on *unlighted as well as lighted* ATONs. In addition to general information regarding ATONs the *Light List* includes specific information on each ATON such as its LLNR, the *name and location* of the ATON, the *geographic coordinates* (latitude and longitude), *characteristics, height, nominal range* (for a wider variety of ATONs than found on the nautical chart), an *identification of the structure,* and *pertinent remarks.*

The organization of the *Light List* is actually quite logical, but requires some study to be used effectively. When all else fails, the index at the back of each volume is helpful.

Much of the information on ATONs shown in the *Light List* is identical to that provided on nautical charts. However, the *Light List* does contain information not found on charts and, additionally, is revised more frequently than most nautical charts and, therefore, is more likely to contain up-to-date information. (However, a properly corrected chart is also up to date.)

Perhaps the most useful information contained in the *Light List* that does not appear in the nautical chart is a brief description of the structure and the accompanying remarks. The description of the structure is particularly useful for identifying lights during daylight conditions. For example, the route from seaward up the Delaware Bay is marked by several lighthouses, including the Brandywine Shoal Light (see figure 5–4), Fourteen Foot Bank Light, Miah Maull Shoal Light, Elbow of Cross Ledge Light, and Ship John Shoal Light. (Photographs in this chapter show two of these lights.) Mariners with local knowledge can readily identify these lights by their distinctive physical appearance.[6] However, those without local knowledge would certainly benefit from the following descriptions taken from the *Light List, Volume II, Atlantic Coast, Toms River, New Jersey to Little River, South Carolina (1993):*

> "Brandywine Shoal Light-Cylindrical concrete structure, adjacent to old screwpile with red sector from 151 degrees to 338 degrees covering shoal area southwest of Cape May. As with several other lights in the area, this light is equipped with an emergency light of lower intensity with same characteristic as main light when main light is extinguished.

[6]In SAR cases on the Delaware Bay in which the distressed mariner reports a position near one of these lights, rescue authorities often ask the mariner to describe the light. This procedure can save fruitless search hours in cases where the distressed vessel does not have an accurate position fix and misidentifies the light.

"Fourteen Foot Bank Light-White tower and dwelling on black cylindrical pile.

"Miah Maull Shoal Light-Red conical tower, on gray conical pier; red cylindrical watch room and black lantern.

"Elbow of Cross Ledge Light-Red skeleton tower with small white house on international orange cylindrical base.

"Ship John Shoal Light-Brown octagonal dwelling with pyramidal roof; on cylindrical pier. Light has red sector from 138 degrees to 321.5 degrees covers shoals on east channel. High intensity beam down Miah Maul Range."

Additionally, the *Light List* provides specific information on ATONs which are seasonal—information not shown on the nautical chart. For example, this same volume of the *Light List* notes that the Deadman Shoal Lighted Buoy IDS which is normally equipped with a flashing green light with a 4-second period is replaced by an unlighted winter marker from December 15 to April 1 of each year.

–The U.S. Coast Pilot

The *U.S. Coast Pilot* also provides information on lights and other ATONs. The scope of the material provided in the *U.S. Coast Pilot* is quite broad (see other chapters of this manual) and, as a result, coverage of ATONs is less complete than can be found in the *Light List.* Nonetheless, the *U. S. Coast Pilot* does contain useful information on selected ATONs. In particular, the *U. S. Coast Pilot* often provides descriptions of lights that are useful for identifying the light structure during daylight hours. For example, here are a few descriptions of lights taken from the *U.S. Coast Pilot Volume 3 (1993), Atlantic Coast: Sandy Hook to Cape Henry:*

"The entrance to South River is between Saunders Point and Thomas Point, 1.8 miles northeastward. Thomas Point Shoal Light (38° 53.9' N, 76° 26.2' W), 43 feet above the water, is shown from a white hexagonal tower on piles, in depths of 5 feet near the outer end of the shoal 1.2 miles east-southeastward of the point; a fog signal is at the light. The light is 1.5 miles due west of a point on the bay ship channel 124.2 miles above the Capes." (p. 176)

"Solomons Lump Light (38° 02.9' N, 76° 00.9' W), 47 feet above the water, is shown from a white octagonal dwelling, with a square tower, on a brown cylindrical base, in depths of 7 feet on the Smith Island side of Kedges Straits." (p. 190)

"Sharps Island Light (38° 38.3' N, 76° 22.5' W), 54 feet above the water, is shown from a leaning, brown tower on a cylindrical pier, in 10 feet at the north end of a shoal that bares at the east end...." (p. 194) [This description is particularly valuable to those without local knowledge. The structure actually leans a great deal, and it is difficult to believe that this is an ATON when approaching from certain angles in daylight!]

–Published Guides and Other Books

Published cruising guides and other books often have descriptions and photographs which are useful to the mariner. Books on lighthouses (e.g., Caldwell, de Gast, Holland), in particular, often contain photographs which facilitate daylight identification. These books are not designed for navigational purposes, however, and the appearance of the light may have changed since the photograph was taken.[7]

Buoys

According to the somewhat lengthy official definition in the *Desk Reference Guide,* a *buoy*...

> "is a floating object, other than a lightship, moored or anchored to the bottom as an aid to navigation. Buoys may be classified according to shape, as spar, cylindrical or can, conical, nun, spherical, barrel, or pillar buoy. They may also be classified according to the color scheme, as a red, green, or checkered buoy. A buoy fitted with a characteristic shape at the top to aid in its identification is called a topmark buoy. A sound buoy is one equipped with a characteristic sound signal, and may be further classified according to the manner in which the sound is produced, as a bell, gong, horn, trumpet, or whistle buoy. A lighted buoy is one with a light having definite characteristics for detection and identification during darkness. If the light is produced by gas it may be called a gas buoy. A buoy equipped with a marker radiobeacon is called a radiobeacon buoy. A buoy with equipment for automatically transmitting a radio signal when triggered by an underwater sound signal is called a sonobuoy. A combination buoy has more than one means of conveying intelligence; it may be called a lighted sound buoy if it is a lighted buoy provided with a sound signal. Buoys may be classified according to location, as channel, midchannel, middle ground, turning, fairway, bifurcation, junction or sea buoy. A bar buoy marks the location of a bar. A buoy marking a hazard to navigation may be classified according to the nature of the hazard, as obstruction, wreck, telegraph, cable, fish net, dredging, or spoilground buoy. Buoys used for particular purposes may be classified according to their use, as anchor, anchorage, quarantine, mooring, warping, swinging, marker, station, watch, or position buoy. A light-weight buoy especially designed to withstand strong currents is called a river buoy. An ice buoy is a sturdy one used to replace a more easily damaged buoy during a period when heavy ice is anticipated."

The above definition also identifies some of the many navigational uses of buoys. Perhaps the most significant use of a buoy is to enable the mariner to stay in safe water and avoid unseen hazards to navigation.

As noted, buoys are the most common ATON. Approximately 25,500 federal buoys marked U.S. waters in 1993. Buoys may be lighted and/or have fog signals (see below), but most (82 percent) are unlighted can or nun buoys.

Physically, buoys are floating ATONs that are moored to the seabed by concrete sinkers attached to the body of the buoy with chain or synthetic rope of various lengths. Buoy moorings vary in length, being sufficiently long to accommodate the water depth where the buoy is located, plus an allowance for variations in water depth. The mooring lengths define a "watch circle," and buoys move within this circle depending upon wind, current, and tidal height. The size of the watch circle is not reflected in the chart.

[7]As an example of this point, an attractively illustrated book (see de Gast) reprinted in 1993, contains a dramatic photograph of the Sharps Island Light referred to above. This light (correctly described in the *USCG Light List*) is leaning as a result of ice damage in 1977. The photograph of this light, unchanged since the original 1973 edition of this book, does not reflect this damage. No doubt the light looks better in its undamaged state, and the author did not intend to write a navigation text.

More than 80 percent of buoys in U.S. waters are unlighted. Unlighted nun buoy.
Official U.S. Coast Guard photograph.

Buoys vary substantially in size and physical appearance. The reader is directed to any of several references at the end of this chapter for illustrations and photographs of various types of buoys.

–A Brief Digression: Position Fixing with Buoys

It is noted above that ATONs can be used for fixing the vessel's position. Although it may be common practice to use both fixed and floating ATONs for this purpose, *the prudent mariner should try to avoid fixing the vessel's position using floating aids.*[8] As noted in the introductory material published in each *Light List:*

> "Buoy positions represented on nautical charts are approximate positions only, due to the practical limitations of positioning and maintaining buoys and their sinkers in precise geographical locations. Buoy positions are normally verified during periodic maintenance visits. Between visits, atmospheric and sea conditions, seabed slope and composition, and collisions or other accidents may cause buoys to shift from their charted locations, or cause buoys to be sunk or capsized....
>
> *...Prudent mariners will use bearings or angles from fixed aids to navigation and shore objects, soundings, and various methods of electronic navigation to positively fix their position."* [Emphasis added.]

Guidance on the use of buoys for position fixing offered in COMDTPUB P16502.8, *U. S. Coast Guard Aids to Navigation* (p. 39) is even more explicit:

> "In order for mariners to derive maximum use from aids to navigation, the different aids to navigation are shown on nautical charts. Thus, mariners are aware of the aids to navigation which they may expect to pass, and may plot any bearings which they take for the purpose of determining their position. DO NOT USE BUOYS TO PLOT A FIX." [Emphasis in original.]

[8]An articulated light (see main text) is a buoyant structure tethered directly to the seabed in such a manner that it has no "watch circle." Although similar to a buoy in some respects, it is regarded as a fixed ATON *for charting purposes.* However, these should be treated as *floating aids* in terms of position fixing.

Buoys could be off-station at any time, but are more likely to be off-station after storms, and in icy conditions. During the severe flooding of the Midwest in the summer of 1993, for example, it was estimated (*Professional Mariner,* Issue No. 3) that as many as 70 percent of the thousands of ATONs in the area needed to be replaced. Severe ice and snow storms in the Northeast in the following year also required numerous buoys to be reset in the Delaware Bay and New York harbor.

It is recognized that there are circumstances where fixed ATONs may not be available for position fixing yet numerous buoys might be present in the area. Any position based solely on buoys should be regarded with a healthy skepticism and verified using fixed ATONs at the first opportunity.

Buoys can be damaged and moved off station by ice, one of the reasons that position-fixing with buoys is not recommended. Here crew from the USCG Red Oak work on an ice-damaged buoy.
Official U.S. Coast Guard photograph.

–Charting Practices

As with other ATONs, buoys are charted with a symbol and one or more labels providing capsule information about the buoy. As noted, generally only buoys listed in the *Light List* are charted. In most cases this presents no difficulty for the mariner. However, there are numerous buoys that are not charted. In particular, buoys marking channels along the Atlantic coast and gulf coast that shift frequently are generally omitted. (Charting these would require excessively frequent revisions.) Where these buoys are not charted, a note is added explaining that these buoys are omitted. In this case a standard note is added to the chart:

Entrance to Inlets

The entrance channels at the inlets not protected by jetties are subject to frequent changes. The buoys are not charted because they are frequently shifted in position. Buoys are removed if shoaling makes inlets unnavigable.

Entries for such buoys in the *Light List* do not contain latitude and longitude coordinates.

Note also that a given chart may omit buoys (and other information) which are shown on a larger scale chart of the area.

–Symbols (Q)

There are numerous charting symbols used to depict buoys of various types. Figure 5–5, taken from Chart No. 1, provides a sample for review. Chart No. 1 should be studied in some detail to ensure familiarity with the various buoy symbols. Refer to table 5–2 for guidance on the significance of lateral aids. Definitions of various types of buoys can be found in the Glossary in appendix A of this manual and the *Light List*. Additionally, the *Light List* provides an explanation of the significance of each buoy to the mariner.

The position of a buoy is shown with a small circle, the "approximate position" symbol (see Chapter 6) because of the practical limitations in positioning and maintaining buoys and their sinkers in accurate geographic locations. Buoys are charted, insofar as possible, in their published position on large-scale charts. In cases where a buoy position coincides with the symbol for another critical feature, such as a rock awash, the buoy may be charted slightly off position for clarity, but always on the same azimuth as the feature that it marks. If buoys are on opposite sides of a dredged channel and plot less than 0.5 mm apart, the aids may be separated to 0.5 mm.

Channel buoy symbols (e.g., the diamond shape) are generally shown at a 65° angle from the channel lines, with the symbol pointing toward the top of the chart. Buoy symbols marking the limits of fish trap areas are oriented so as to fall inside the area. For other buoys the orientation of the buoy symbols is approximately 25° from the vertical with the symbol inclined toward the label.

Lighted buoys, except superbuoys, are charted with a magenta disk 2.5 mm in diameter, centered on the circle located at the base of the buoy symbol. The few buoys equipped with a RACON[9] are charted with a 7.1 mm diameter magenta circle centered on the circle located at the base of the buoy.

Superbuoys, including single point mooring buoys, *oceanographic data acquisition systems buoys* (ODAS), and *large automated navigation buoys* (LNB or LANBY), share a unique symbol (Sections P 8 and Q 26 of Chart No. 1). See figure 5–6 for an illustration.

[9]The word RACON is derived from RAdar beaCON. A RACON produces a coded response (Morse) when triggered by a radar signal.

Buoys and Beacons			
IALA Maritime Buoyage System, which includes Beacons → Q 130			
1	○	*Position of buoy*	
Colors of Buoys and Beacon Topmarks			
Abbreviations for Colors → P			
2	G	*Green and black*	
3	R "2"	*Single colors other than green and black*	
4	RG	*Multiple colors in horizontal bands, the color sequence is from top to bottom*	
5		*Multiple colors in vertical or diagonal stripes, the darker color is given first*	
6		*Retroreflecting material*	
Note: Retroreflecting material may be fitted to some unlit marks. Charts do not usually show it. Under IALA Recommendations, black bands will appear blue under a spotlight.			
Lighted Marks			
Marks with Fog Signals → R			
7		*Lighted marks on standard charts*	Fl.G Fl.R
8		*Lighted marks on multicolored charts*	Fl.R Iso Fl.G
Topmarks and Radar Reflectors			
For Application of Topmarks within the IALA-System → Q 130 *Topmarks on Special Purpose Buoys and Beacons* → Q			
9		*IALA System buoy topmarks (beacon topmarks shown upright)*	
10		*Beacon with topmark, color, radar reflector and designation*	No 2 Name
11		*Buoy with topmark, color, radar reflector and designation*	No 3
Note: Radar reflectors on floating marks are usually not charted.			

Fig. 5-5. An Excerpt From Chart No. 1: Buoys

Continued on next page

Buoys	*Features Common to Buoys and Beacons* → Q 1–11			
Shapes of Buoys				
20	N	*Conical buoy, nun buoy*		
21	C	*Can or cylindrical buoy*		
22	SP	*Spherical buoy*		
23	P	*Pillar buoy*		
24	S	*Spar buoy, spindle buoy*		
25		*Barrel buoy*		
26		*Super buoy*		
Light Floats				
30		*Light float as part of IALA System*	Fl.G.3s No 3 Name	
31		*Light float (unmanned light-vessel) not part of IALA System*	Fl.10s12m26M	
Mooring Buoys				
Oil or Gas Installation Buoy → L			*Small Craft Mooring* → U	
40		*Mooring buoys*		
41		*Lighted mooring buoy (Example)*	Fl.Y.2,5s No 1	
42		*Trot, mooring buoys with ground tackle and berth numbers*	1 2	
43	*See Supplementary national symbols* S, t	*Mooring buoy with telegraphic or telephonic communication*		
44		*Numerous moorings (example)*	*Small Craft Moorings*	

Continued

Fig. 5-5. An Excerpt From Chart No. 1: Buoys

LANBY silhouetted against rising sun.
Official U.S. Coast Guard photograph.

As a point of interest the present LANBYs—built originally to replace lightships—are now nearing the end of their service life and are being replaced by smaller, solar-powered *exposed location buoys* (ELBs). The newer ELBs are cheaper to buy and maintain than the older diesel-powered LNBs (Walsh).

–Charted Characteristics

The characteristics of buoys include color and shape, and, if so equipped, the color and period of their light. Characteristics are abbreviated as shown in Chart No. 1 (Sections Q 2 through Q 71, and a through U) and the *Light List.* These characteristics are important to the mariner for identification purposes. Indeed, as with lights, all mariners are cautioned to establish positive identification of each buoy in the vicinity of the vessel's track. Noticeably absent from this list of characteristics are the height of the buoy and the nominal range (if lighted). (Nominal ranges for selected buoys can be found in the *Light List,* and typically varies from about 4- to 6-nautical miles for most lighted buoys.)

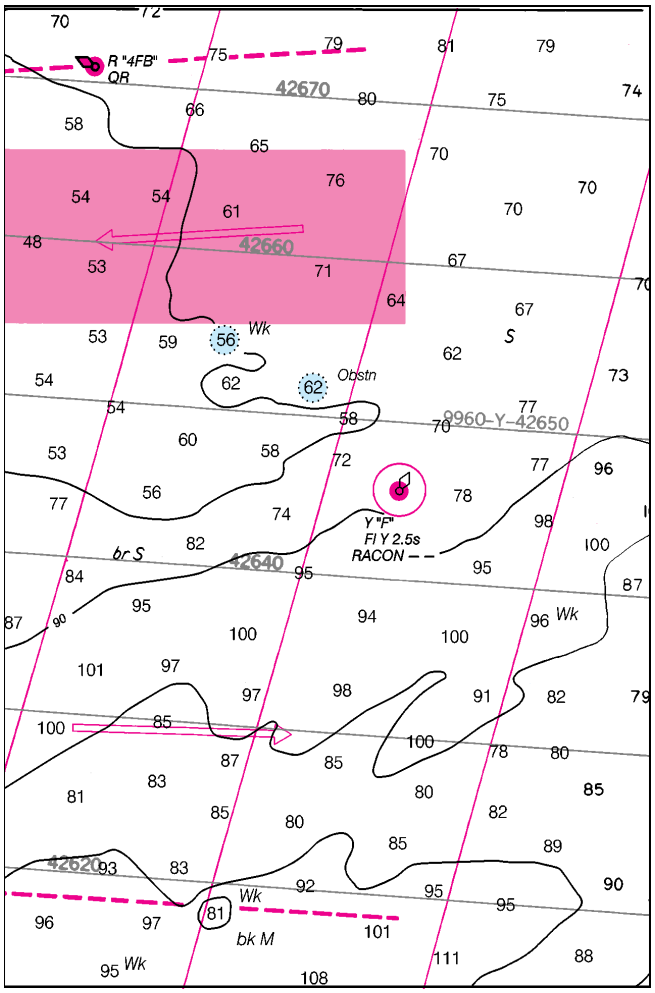


Fig. 5-6. Excerpt from NOS Chart No. 12214 (Cape May to Fenwick Island). Note the LANBY in this illustration. This buoy has a RACON with the identifier (— —) as well as a light and a horn.

Buoy characteristics are shown in italic type.[10] These labels are placed so as not to overlap with wreck symbols, shoals, least depths, and other critical features. Buoys are identified on charts by their shape (can, nun, spherical buoy, spar buoy, or pillar buoy) and by any audible signal they emit (bell, whistle, gong). Buoys (with the exception of mooring buoys) are labeled as to their color using specified abbreviations given in Chart No. 1.[11] For example, red buoys are shown with magenta fill, labeled "R," and green buoys with green fill and labeled "G."

The identifying number (or letter(s)) painted on the buoy (not the LLNR) is shown in quotation marks, e.g., "22."

Light characteristics and period are also presented in the label in much the same manner as noted above for lights.

Private buoys listed in the *Light List* are identified with the label "Priv" in italic print. The service name is charted on military ATONs, e.g., "Navy." Privately maintained buoys not listed in the *Light List* are not generally charted.

A radar-enhancing structure or reflective material has been installed on nearly all major buoys and many minor buoys. Therefore, reference to this feature is not charted as part of the buoy's characteristics. Instead, the following note is included on the chart:

> "Radar reflectors have been placed on many floating aids to navigation. Individual radar reflector identification on these aids has been omitted from this chart."

On large-scale charts, the characteristics of buoys are shown in the following standardized order; color (omit if black) shape, (if unlighted), number (or letter(s)), flash character (if lighted), light color (if lighted), light period (if lighted), and fog signal (if so equipped). For example, the complete legend would be charted as follows:

[10]This is consistent with the convention that floating objects are shown in italics.
[11]Black buoys are not discussed in this manual as these are being phased out.

Lighted Buoy	Unlighted Buoy
R "22"	R
Fl R 4s BELL	N "22"

In congested areas and on smaller scale charts, some of these characteristics are sometimes omitted. Characteristics of lighted buoys are omitted in the following order: period, color, number, light color, and flash characteristics. For unlighted buoys, the corresponding order is: color then number.

Space constraints do not permit an exhaustive discussion of the many types of buoys found in U.S. waters. However, three of the most common types of buoys are briefly reviewed.

–Channel Buoys

These buoys mark the edges of navigable channels. In the IALA-B system, red buoys mark the starboard side of the channel, and green the port side of the channel when proceeding from seaward. Unlighted red buoys have a conical shape, called a nun, and bear even numbers, increasing from seaward. These would be charted using the first symbol shown in Section Q 3 (Q 20) of Chart No. 1 and carry the label R (for red), N (for nun), and the number of the buoy (e.g., "6") in quotation marks. If lighted, this buoy would have a somewhat different physical appearance (e.g., a larger buoy rather than the simple nun), a red light atop the buoy, and would be charted by adding the magenta disc and the characteristics of the light would be noted as discussed above.

Unlighted green buoys have a cylindrical shape, called a can, and bear odd numbers, increasing from seaward. These would be charted using the first of the symbols shown in Section Q 2 (Q 21) of Chart No. 1, and carry the label G (for green), C (for can), and the number of the buoy (e.g., "7") in quotation marks. If lighted, this buoy would have a somewhat different physical appearance (e.g., a larger buoy rather than the simple can), a green light atop the buoy, and would be charted by adding the magenta disc and the characteristics of the light would be noted as discussed above.

Incidentally, mariners are sometimes confused by the exact meaning of the phrase "returning from seaward" in certain instances. The nautical chart should always be consulted to verify the safe side for passing any buoy with lateral significance. Additionally it is worth noting that no buoy should be passed very close aboard; buoys can move throughout the watch circle (endangering the vessel). Moreover, buoys may be located outside of the channel (generally noted in the *Light List)* in cases where the channel is deep. A vessel that ventures too close to the buoy may no longer be in the channel.

A Standard Lighted Radar Reflective Buoy (no sound).
Official U.S. Coast Guard Photograph.

–Junction Buoys

Junction buoys typically mark a junction of two channels and can be passed safely on either side. As with other buoys, these can be lighted or unlighted.

> If unlighted, the buoy would resemble a green can (if the preferred channel were to the right when approaching from seaward) or a red nun (if the preferred channel were to the left when approaching from seaward). The nun would have horizontal red and green bands with the topmost band red. It would be charted by the symbol shown in Section Q 4 of Chart No. 1. The diamond shape would have two fills—red and green (topmost red)—and the letters RG along with the letter(s) on the buoy shown in quotation marks.
>
> If lighted, these would be larger buoys, but retain the same physical color and lettering scheme. The color of the light matches the color of the topmost band. These would be charted using the same symbols as given above, except that the magenta disc would be added, along with the light characteristics as noted above.

–Midchannel Buoys

Midchannel buoys (also called fairway buoys) mark safe water at or near the center of the channel and can be passed on either side. Physically these can be lighted (with a white light blinking the Morse "A") or unlighted, with either the characteristic shape of the lighted buoy or a spherical shape. These are vertically striped red and white. These are charted by the first of the symbols shown in Section Q 5 of Chart No. 1, with or without the magenta disc depending upon whether the buoy is lighted or not. The label would contain the color code *RW* (for red and white), and the identifying letter on the buoy, together with the light characteristic *Mo (A)* if appropriate.

Fog Signals (R)

According to official charting definitions in the *Nautical Chart Manual, fog signals...*

> "are audible aids used to warn of danger and to provide the mariner with a means of determining a craft's position when visibility is obscured by fog, snow, rain, smoke, or thick weather. Among the devices in common use as fog signals are the following:
>
> "Diaphones produce sound by means of a slotted reciprocating piston actuated by compressed air. 'Two-tone' blasts consist of two tones of different pitch, beginning with a high-pitched blast and ending on a low pitch.
>
> "Diaphragm horns produce sound by means of a disc diaphragm vibrated by compressed air or electricity. Duplex or triplex horn units of differing pitch produce a chime signal.
>
> "Sirens produce sound by means of either a disk or a cup-shaped rotor actuated by compressed air or electricity.
>
> "Whistles produce sound by compressed air emitted through a circumferential slot into a cylindrical bell chamber.
>
> "Bells produce a distinctive sound by the vibration of a hollow, cup-shaped metallic vessel which gives forth a ringing sound when struck.
>
> "Gongs produce a sound by the vibration of a resonant disc."

There were approximately 1,620 fog signals on federally maintained ATONs in 1993, the majority (75 percent) of which were installed on buoys.

These fog signals are used by the mariner in much the same manner as lights or buoys. And, indeed, these signals are often collocated with fixed or floating aids to navigation. Each

fog signal has specific characteristics by which it can be distinguished. The signal characteristic is the phase relationship of the recurring sound emissions. Here are a few pointers to keep in mind relative to fog signals and operation in fog:

Fog signals on fixed stations and large navigational buoys produce a specific number of blasts and silent periods each minute, when operating, to facilitate positive identification.

Fog signals on buoys are generally activated by the motion of the sea: therefore, they do not emit regular signal characteristics and, when the sea is calm, may emit no sound signals.

Fog signals can be activated by several means (including manually, remotely, or with a "fog detector"). In cases where a fog detector is employed, there may be a delay in the automatic activation of the signal. Additionally, fog detectors may not be capable of detecting patchy fog conditions.

The sound from a fog signal may not be sufficiently loud to be heard over the noise of an engine. Therefore, it may be useful to periodically reduce the engine to idle power—or turn it off completely—to listen for these signals.

Remember to sound the appropriate signals when operating in fog. If visibility is so impaired to necessitate reliance on fog signals, it is sufficiently poor to require appropriate sound signals from all vessels. Note also that speed should also be adjusted to the prevailing circumstances.

Particular attention should be paid to positive identification of buoys in sequence. When a buoy in sequence is missed, consider running a search pattern to find the buoy. Moreover, use all available means of navigation, including electronic position-finding aids, radar, and depth-sounder information.

Finally, as noted in the *Light List,* "mariners should not rely on sound signals to determine their position. Distance cannot be accurately determined by sound intensity. Occasionally, sound signals may not be heard in areas close to their location. Signals may not sound in cases where fog exists close to, but not at, the location of the sound signal."

These important caveats aside, fog signals can be very useful aids to navigation in circumstances of restricted visibility.

–Charting Practices

Fog signals are depicted by a *symbol* and appropriate *labels and notes.* In most cases, fog signals are located on fixed or floating aids to navigation. Therefore, the fog signal is charted using the appropriate symbol for the light or buoy. Information on the fog signal is included in the labels associated with the ATON. In some cases, fog signals are included on structures not normally used for navigation. In this case the *landmark* symbol (see Chapter 6) is used, and the appropriate label appended.

–Labels and Notes

Fog signals are labeled as "DIAPHONE," "HORN," "SIREN," "WHISTLE," "BELL," or "GONG." The appropriate designation (see Section R of Chart No. 1) is used as part of the characteristic of the aid. Refer to the *Light List* for a detailed presentation of the sound sequence and period.

U. S. Coast Guard ATON personnel servicing daymark and light, Miami, Florida.
Official U.S. Coast Guard Photograph

Daybeacons (Q)

According to official charting definitions in the *Desk Reference Guide,* a *daybeacon*...

> "...is an *unlighted fixed aid,* specifically designated for navigation, placed on shore or on marine sites. They are established and maintained by the U.S. Coast Guard. They are identified by their color and the shape of the daymark. Reflective borders are placed on certain daybeacons to assist the navigator using a searchlight to more readily locate them at night. The color of the reflectors has the same significance as the color of the aid." [Emphasis added.]

Key words in the above definition are "beacon" and "fixed." Contrary to the popular sense of the word "beacon," daybeacons are unlighted aids.[12] Moreover, these are fixed structures and, therefore, admonitions against

[12]According to Naish (see references), the word beacon comes from the German word *bake.* The meaning of this word in Frisia and North Germany is a signal pole or construction placed in or near the water. The plural form, *baken,* is the source of the English word *beacon.*

using floating structures (noted in the above section on buoys) for position fixing do not apply. Daybeacons are used by mariners in the same manner as lights and landmarks—e.g., to identify channels and to fix the vessel's position. The lack of lighting limits the utility of these aids for night navigation but, despite this limitation, daybeacons appear surprisingly bright in the reflected glare of the vessel's searchlight. Daybeacons include lateral daybeacons (in red or green), preferred channel daybeacons, safe water daybeacons (in red-and-white), and special-purpose daybeacons (yellow quarantine area daybeacons, regulatory warning daybeacons).

There were approximately 11,900 federally maintained daybeacons in U.S. waters in 1993, less than one-half the number of buoys. Daybeacons are often used in shallow inland waters, because these are less expensive to install and maintain than buoys. Additionally, these have the advantage of being fixed, rather than floating structures. Physically, these consist of one or more piles driven into the bottom, surmounted by signboards called daymarks.

–Charting Practices

This section provides information on charting practices for daybeacons and related information. Charting conventions consist of a *symbol* and associated *labels* to describe the characteristics of the daybeacon.

–Daybeacon Symbols

The daybeacon symbols are shown in Section Q (80 through 83) of Chart No. 1. The center of the daybeacon symbol is located at its geographic position. Daybeacons along dredged channels are also charted in their true positions, unless they are on opposite sides of a channel and plot less than 0.5 mm apart. In this case, to add clarity, the aids may be separated to 0.5 mm. However, daybeacons are not moved off ranges (see below) nor natural objects.

There are two principal standard symbols used to depict daybeacons; a *triangle* and a *square.* Triangular daybeacons (starboard hand red marks with even numbers in the IALA-B system) are typically represented by an equilateral triangle 2.0 mm on each side. (To avoid chart clutter in congested areas, a 1.5 mm triangle may be substituted.) Red triangular daybeacons are shown with a magenta fill, those with other colors (e.g., preferred channel daybeacons) are unfilled and the colors and identifying numbers or letters are included in the label.

Square daybeacons (port hand marks with odd numbers in the IALA-B system) are typically represented by a square 1.65 mm on each side (or a smaller 1.3 mm square). The square symbol is also used to represent rectangular, round, octagonal or diamond-shaped daybeacons). Green daybeacons are shown with a green fill, those with other colors (e.g., preferred channel, safe water, or special purpose daybeacons) are left unfilled, and the colors and identifying numbers or letters are included in the label.

Figure 5–7 shows daybeacons in the vicinity of Hereford Inlet, New Jersey.

–Daybeacon Labels

Labels include the color(s) of the daybeacon and the identifying numbers and letter(s), charted in black vertical type.[13] Color choices include red (starboard hand markers), designated with an "R," red and green (junction beacons with preferred channel to port), designated with an "RG," red and white (fairway beacons), designated with an "RW," green (port hand markers), designated with a "G,"

[13]Note that these are depicted in upright letters, rather than italics, because these are fixed structures.

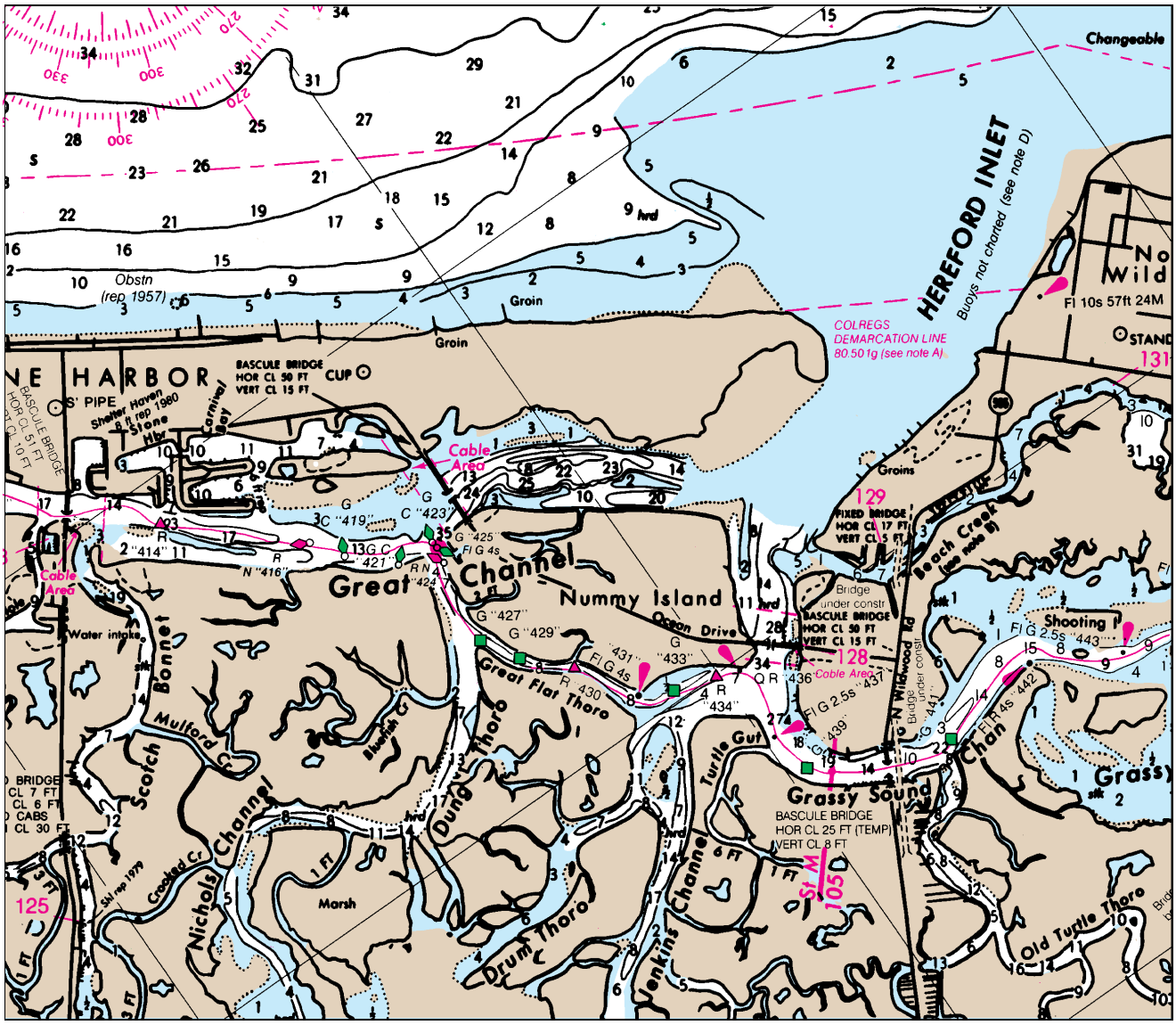


Fig. 5-7. Excerpt from NOS Chart No. 12316 (Little Egg Harbor to Cape May, New Jersey). Note that the buoys in Hereford Inlet are not charted. Note also the daymark symbols marking the Great Flat Thoro. Cupolas and a standpipe can be seen as landmarks. Lights, lighted, and unlighted buoys are also shown.

green and red (junction beacons with preferred channel to starboard), designated with a "GR," yellow (quarantine area, practice area), designated with a "Y," and white (regulatory warning, state boundary), designated with a "W."

Numbers and letters are charted as appropriate. The abbreviation "Bn" is used to depict daybeacons which do not have identifying numbers or letters.

Daybeacons that have information written on the dayboards may have that information (e.g., "Rock") charted as an optional part of the aid characteristic. Private daybeacons are labeled "Priv."

Ranges (M)

According to the *Light List, ranges...*

> "are non-lateral aids to navigation systems employing dual beacons which, when the structures appear to be in line, assist the mariner in maintaining a safe course. The appropriate nautical chart must be consulted when using ranges to determine whether the range marks the centerline of the navigation channel and also what section of the range may be safely traversed. Ranges display rectangular dayboards of various colors and are generally, but not always lighted. When lighted, ranges may display lights of any color."

As constructed, a range consists of two beacons, one is called the front range marker and is lower in height than the other, called the rear range marker. The rear marker is usually located some distance from the front marker. (Often the front range marker is on a fixed structure in the water, and the rear range marker is on land.) When these two markers appear directly in line (one behind the other, but both visible because the rear marker is higher) they are said to be "in range," or "in transit" in British usage. The line defined by the range is called a "range line" or "leading line." Daybeacons and other charted objects forming a range are often called "leading marks." Likewise range lights are sometimes termed "leading lights."

Approaching the front range marker, if the two marks are exactly in range, the vessel's position is exactly along the range line. If the lower marker is to the left (right), the vessel must alter course to the left (right) to rejoin the range. Because of geometric considerations, the horizontal angle between the range markers seen by a vessel a fixed distance away from the channel centerline *increases* with decreasing distance (Brogden). Thus, the sensitivity of the angle to side-to-side excursions increases as the vessel draws closer to the markers. The range markers provide an accurate and easily obtained line of position. Artificial ranges (lighted or unlighted) have been installed in line with channels in many ports. In cases, such as the Delaware River, where the river has many bends, separate ranges mark each of the straight sections, and navigation amounts to following a sequence of ranges throughout the voyage. Most ranges are aligned with the center of the channel, but in some areas more than one range is used to define the inbound and outbound ranges of the channel.

Range lights may be of any standard light color or period, the principal requirement being that these stand out from their surroundings. Thus, for example, green rather than red or white lights might be used to mark a range that would be aligned with the setting sun. Most range lights show a high intensity beam within only a very narrow arc of visibility marking the channel centerline and are obscured around the remainder of the horizon. These lights appear to lose brilliance rapidly as the vessel strays from the range line. Range lights are often visible at distances considerably greater than the actual usable range, to ensure that they can be seen in adverse weather conditions.

After extensive research and testing, the USCG is preparing to install "light pipes" on many channel ranges around the country (*Professional Mariner,* 1994). These light pipes are fiberglass tubes, approximately 15 feet long and 6 inches in diameter with a special film on the inside and a light source at one end. The light pipe is placed directly in front of the boards of the range markers. The light pipes are highly conspicuous at ranges up to several miles, and—compared to conventional lights—it is much easier to detect the alignment (or misalignment) of two vertical lines of light. Light pipes will be supplied with various colors and characteristics in the same manner as conventional range lights.

–Charting Practices

Only ranges published in the *Light List* are charted. As with other ATONs charting conventions consist of a *symbol* and associated *labels.*

Range lights are separately charted as noted above in the section on lights. If the scale is too small to chart a pair of range lights individually, these are shown with one light dot and labeled, for example, "2F." A *passing light,* if installed, is generally placed on the front light of a range structure located in the water. The passing light serves as an extra precaution to alert mariners to the existence of the range light structure when approaching the light from its dark side at night. (Not all ranges are equipped with passing lights, however.) Because the passing light is of secondary importance to the range light, its characteristic is charted on a separate line below the range light label—in the same order as shown in the *Light List.* If the visibility of the passing light is included in the *Light List,* it is also included in the chart label.

–Symbol (M 1)

The range symbol is shown in Section M 1 of Chart No. 1. The usable portion of ranges is shown by a solid line to the point where the vessel should leave the range. (Defining the limits of the range is obviously of key importance for curving channels.)

From the point where the range should be left, the range is continued with a short-dashed line to the rear navigational aid.

In the event of extreme shoaling or shoaling over a large area in an improved channel, range lines may be dashed, or even omitted, through a shoaling area that is depicted by hydrography.

Figure 5–8 shows ranges used to mark a section of the upper Delaware River, as shown on NOS Chart 12314 (Delaware River, Philadelphia, PA, to Trenton, NJ).

–Range Labels

The range label shows the name of the range and the bearing of the range (in degrees true along the range in the direction of the front marker) if these are published in the *Light List* and considered useful to the mariner.

–Dredging Ranges

The USACE has established ranges in some areas to control channel maintenance dredging. These ranges (often unlighted) are not intended for navigation and are charted only as a "DREDGING RANGE." Structures comprising this range are charted as landmarks (see Chapter 6). If the dredging structure is listed in the *Light List,* the structure label provides light and fog signal information.

–Natural Ranges

Spires, cupolas, towers, tanks, and other artificial or natural features may form "natural ranges" which chart users sometimes recommend for charting. These natural ranges are not charted unless recommended by the USCG and published in the LNM.

Radiobeacons and Related Aids (S)

A brief introduction to radiobeacons provided in the *Light List* states,

> "As the first electronic navigation system of navigation, radiobeacons provided offshore coverage and also became the first all-weather electronic aid to navigation. The Coast Guard operates about 200 radiobeacons located on the Atlantic, Gulf, and Pacific coasts, and on the Great Lakes. These radiobeacons are located at lighthouses, on large buoys and along the coasts. All positions are charted.
>
> "In order to use this system, the mariner needs a radio direction finder, which is a specifically designed radio receiver with a directional antenna. This antenna is used to determine the direction of the signal being emitted by the shore station, relative to the vessel.
>
> "The basic value of the radiobeacon system lies in its simplicity of operation and its relatively low user costs, even though the results obtained may be somewhat limited. The general problems and practices of navigation when using

radiobeacons are very similar to those encountered when using visual bearings of lighthouses or other charted objects.

"A radiobeacon is basically a short range navigational aid, with ranges from 10 to 175 nautical miles. Although bearings can be obtained at greater ranges, they will be of doubtful accuracy and should be used with caution. When the distance to a radiobeacon is greater than 50 miles, a correction is usually applied to the bearing before plotting on a Mercator chart. These corrections, as well as information on accuracy of bearings, plotting, and other matters are contained in...Radio *Navigation Aids*...[or the *U.S. Coast Pilot*]."

An individual radiobeacon can be used to determine a single LOP and for tracking or homing purposes. If the vessel makes a 90° "dog leg" of known length, the approximate

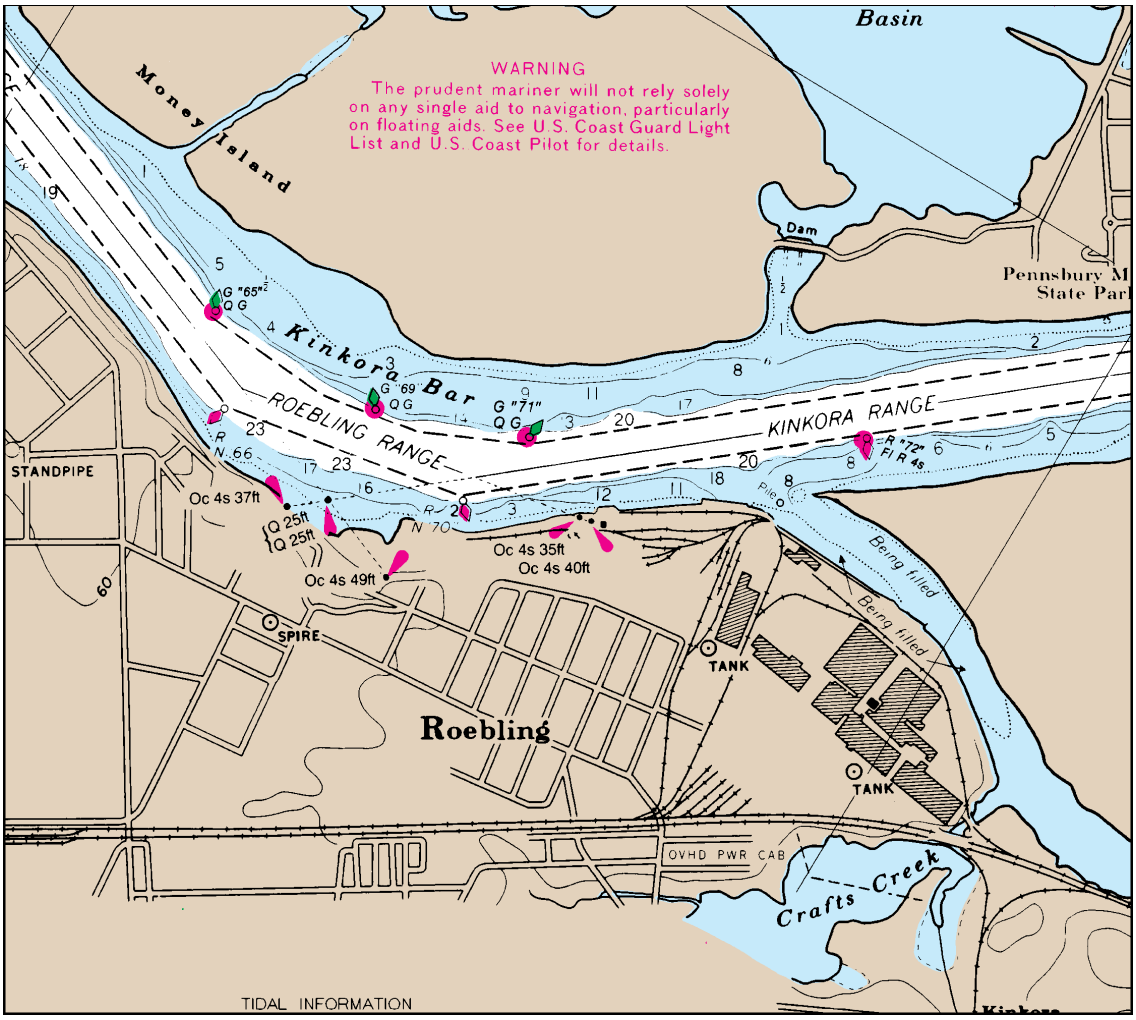


Fig. 5-8. Excerpt from NOS Chart No. 12314 (Delaware River, Philadelphia, PA, to Trenton, NJ). Three ranges are shown on this inset. The rear range marker for the Kinkora Range is an occulting white light with a 4-second period. The front range marker for this same range is a quick-flashing white. The boundary between the Roebling Range and the Kinkora Range is close to the unlighted red nun "70." Green buoy "71" is a lighted quick-flashing buoy. The reason that the quick characteristic is used is that two course changes are necessary over a short distance. Landmarks shown include tanks and a spire.

distance off (Maxim) a single radiobeacon can be calculated from the length of the dog leg and the degrees of bearing change. Radiobeacons are typically located at or near-harbor entrances to maximize the utility of the homing or tracking capability of the system. The LOP from a radiobeacon can be crossed with another LOP (e.g., from a nearby radiobeacon or visual aid) to determine a fix. Mariners using radiobeacons for tracking or homing purposes are cautioned to keep track of the vessel's position so as to avoid running aground or into hazardous waters. Historical examples (see Maxim) of homing without distance checks abound. Additional material on radiobeacons can be found in the references listed at the end of this chapter (e.g., Bowditch, Dutton, Hobbs).

For many years, this system, also called *radio direction finder* (RDF), had the largest number of users of any radionavigation system. In recent years, LORAN-C and GPS have become systems of choice for marine navigation. However, many radiobeacons are being modified to broadcast differential GPS corrections, so radiobeacons will continue in service for some time to come.

Marine radiobeacons operate in the 200 to 400 kilohertz region, just beneath the AM broadcast band. These radiobeacons transmit a Morse code identifier for 50 seconds, followed by a 10-second continuous tone at the end of each operating minute:

> The function of the Morse code sequence is to provide positive identification of the radiobeacon. Positive identification of radiobeacons is as important as positive identification of any ATON. Morse code identifiers are often (but not always) an abbreviation of the facility name. Thus, for example, the two letter Morse code identifier for Cape May is "CM," and that for Barnegat Inlet is "BI." However, there are exceptions (Cape Henry, for example, carries the identifier "CB"), so it is necessary to consult the *Light List* for authoritative information. The *Light List* provides the Morse symbols (e.g., Cape May is –.–. – –) so it is not necessary to know Morse code to use the system.
>
> The function of the continuous tone is to provide the best signal for determining an "aural null" in rotating the antenna to determine the bearing to the station.

–Charting Practices

All marine radiobeacons transmitting signals in areas where hydrography and other navigational information is provided are charted. The useful range of the radiobeacon, along with other pertinent information for radiobeacons in U.S. waters is provided in the *Light List.* On charts of scale 1:500,000 and smaller, radiobeacons are not shown if the chart does not permit navigation within their range. (Low power radiobeacons with a useful range of 10 miles or less are normally omitted from small-scale charts where larger scale charts are available.)

This section provides information on charting practices for radiobeacons and related information. Charting conventions consist of a radiobeacon *symbol* and *associated label(s).*

–Symbol (S 1)

Most radiobeacons are collocated with another visual aid to navigation. If so, the chart symbol will include that for the co-located aid, together with a radiobeacon symbol (see Section S 1 of Chart No. 1) consisting of a 7.1 mm diameter magenta circle centered on the position of the aid. For stand-alone radiobeacons, the black "position accurate" landmark symbol (see Chapter 6) is placed at the center of the magenta circle.

–Labels

In addition to providing information about the "host aid" (e.g., buoy, light, etc.), if one exists, the label provides information about the radiobeacon. The label is given in black vertical type if the antenna is attached to a fixed aid, and italic type if the antenna is attached to a floating aid.

The label includes the abbreviation "R Bn," the frequency (in kilohertz), and the Morse code characteristics, regardless of the chart scale.

–Aeronautical Radiobeacons

Aeronautical radiobeacons (which operate on similar frequencies to marine radiobeacons and can be received by the same equipment) are sometimes useful for marine navigation, particularly if located in close proximity to the coastline or if there is no rough terrain between the beacons and the coastline that might distort signal propagation.

If charted, the aeronautical radiobeacon is depicted with a black "position accurate" landmark symbol and a 7.1 mm diameter magenta circle centered on the landmark symbol. A label in conventional black type is placed adjacent to the symbol and clear of the magenta circle. The label includes the abbreviation "AERO R Bn" and the frequency and characteristics of the radiobeacon.

Miscellaneous Related Information

Nautical charts also include information on courses, recommended and alternate courses, routing systems, traffic schemes, and areas and limits. These are discussed in Chapter 7. Trial courses, however are included in this chapter.

–Measured Course (Q 122)

A *trial course* is a course at sea, the ends of which are marked by ranges ashore and the length of which has been accurately measured. Trial courses are used by vessels to calibrate logs and other instruments that measure speed, as well as to prepare graphs or tables of engine *revolutions per minute* (RPM) versus speed through the water. (See Maxim or other references for details.)

A standard symbol (see the excerpt noted in Section Q 122 from Chart No. 1 and reproduced here in figure 5–9) is used to mark the range or measured course ashore. The course and length of the trial course are indicated by a label.

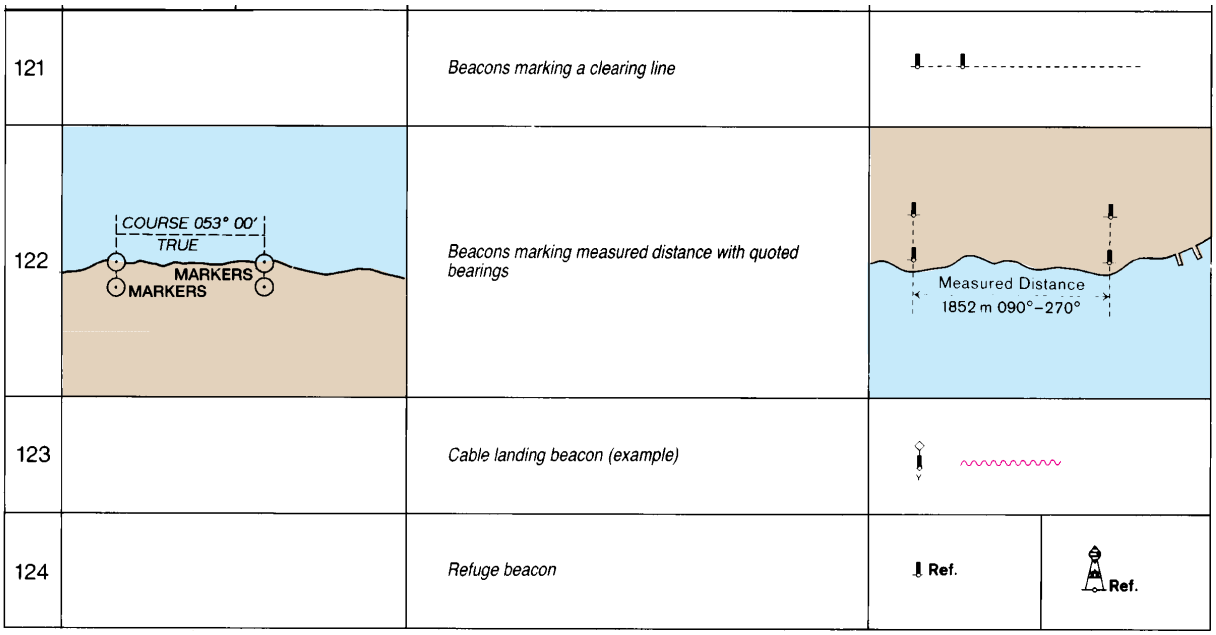


Fig. 5-9. Trial course symbols shown on Chart No. 1.

U.S. Coast Guard Buoy Tender passing by green-lighted radar-reflective buoy. Angle of buoy suggests current is moving from right to left in this photograph. Approximately 4,600 lighted buoys mark U.S. waters.
Official U.S. Coast Guard photograph.

Concluding Remarks

As noted, this chapter is long and quite detailed. Nonetheless, the information presented is very important, and bears reading (preferably with a nautical chart and Chart No. 1 readily at hand) and rereading to ensure complete familiarity with this important topic.

Unlike many of the other objects or features depicted on the chart, ATONs are deliberately placed so as to optimize information provided to the mariner. Because the cost of establishment and periodic maintenance are sufficiently high, ATONs are not casually placed. So it is certain that if an ATON has been put in a given place, it is because this location has real significance to the mariner. Therefore, it is particularly important that the mariner be familiar with the uses, significance, and chart conventions employed to depict this aid.

• •

"The consequences [of poor cartography] could be dire. During the Napoleonic Wars, British losses by shipwreck, caused by bad charts as **well** *as bad weather, were eight times as great as those inflicted by the enemy.*

Wilford

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———*: Daybeacon.*

———*: Light.*

———*:* Marker.

———*:* Obscured Sector.

———*:* Range Line.

———*:* Riprap.

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